

इंटरनेट

मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”

Mazdoor Kisan Shakti Sangathan

“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 15646-2 (2006): Measurements of free surface flow in closed conduits, Part 2: Equipment [WRD 1: Hydrometry]



“ज्ञान से एक नये भारत का निर्माण”

Satyanarayan Gangaram Pitroda

“Invent a New India Using Knowledge”



“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

BLANK PAGE



भारतीय मानक

संवृत नलियों में मुक्त सतह प्रवाह का मापन

भाग 2 उपस्कर

Indian Standard

**MEASUREMENT OF FREE SURFACE FLOW
IN CLOSED CONDUITS**

PART 2 EQUIPMENT

ICS 17.120.20

© BIS 2006

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

FOREWORD

This Indian Standard (Part 2) was adopted by the Bureau of Indian Standards, after the draft finalized by the Hydrometry Sectional Committee had been approved by the Water Resources Division Council.

The measurement of fluid flow and level in partially filled closed conduits pose difficult problems and are not fully documented. An attempt has been made in this standard to give guidance to users on the existing equipments employed and on recent developments in this field.

Efficient and effective engineering design requires accurate and reliable flow information. The flow in closed conduit may vary from zero through a free surface flow condition to a surcharged pipe-full condition, and they may contain both floating and suspended solids as well as other contaminants which may be highly corrosive (for example contaminants resulting from industrial processes). The determination of flows in these conditions demand the design of specialized equipment. In this part of the standard, performance specifications for such equipment are stipulated.

In the formulation of this standard considerable assistance has been derived from ISO/TR 9824-2 : 1990 'Measurement of free surface flow in closed conduits — Part 2: Equipment'.

The other part in this series is:

(Part 1) : 2006 Methods

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard***MEASUREMENT OF FREE SURFACE FLOW
IN CLOSED CONDUITS****PART 2 EQUIPMENT****1 SCOPE**

1.1 This standard (Part 2) specifies performance requirements of equipment for the measurement of free surface flow in closed conduits. It identifies the conditions within which such equipment is required to operate and specifies the level of uncertainty and reliability of measurement, which the equipment is expected to meet.

1.2 This standard is applicable to conduits, having an internal cross-sectional area greater than 0.018 m^2 (for example circular conduits of diameter greater than 150 mm).

1.3 It is not applicable to the measurement of flow in closed conduits, which normally operate under pressure as the result of pumping.

2 REFERENCE

The following standard contains provisions, which through reference in this text, constitutes provisions of this standard. At the time of publication, the edition indicated was valid. All standards are subject to revision and parties to agreements based on this standard is encouraged to investigate the possibility of applying the most recent edition of the standard indicated below:

<i>IS No.</i>	<i>Title</i>
1191 : 2003	Hydrometric determinations — Vocabulary and symbols — Measurement of free surface flow in closed conduits: Part 1 Methods

3 DEFINITIONS

For the purpose of this standard the definitions given in IS 1191 and the following shall apply.

3.1 Free Surface Flows in Closed Conduits — Flows within closed conduits under the influence of gravity only and normally having a free surface.

NOTE — Where the total discharge exceeds the free surface flow capacity for the conduit, that is, the conduit is surcharged, the free surface gets transformed into pressure flow.

4 CHARACTERISTICS OF THE CLOSED CONDUIT SYSTEM**4.1 Structure of the Closed Conduit System**

The general configuration of a closed conduit system is shown in Fig. 1.

A closed conduit is generally located underground, but in certain instances may be above the ground surface. Systems constructed underground generally incorporate means of access through a manhole, which is closed at the surface by a heavy but removable cover.

Access shafts may be provided at frequent intervals along the length of the conduits at a spacing of say 200 m to 400 m. It is normal practice to locate access shafts or other shafts at points of structural change in the conduit system, such as bends or junctions or where, for some reason, inspection or entry to the system may be required.

4.2 Construction of the Closed Conduit**4.2.1 Cross-Sectional Shape**

Closed conduits are generally circular or rectangular in cross-section, but they may be ovoid, horseshoe, square or triangular.

4.2.2 Materials and Surface Characteristics

The conduit may be constructed in solid rock or of dry stone, brick, concrete, metal (for example steel),

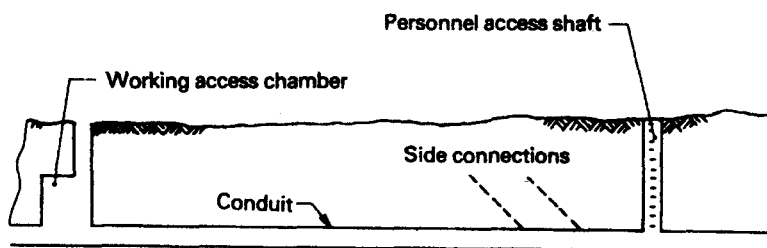


FIG. 1 CLOSED CONDUIT SYSTEM

asbestos cement, earthenware, plastic, resin-bonded fibre, pitch fibre or a combination of these materials. The surface of the conduits may be rough owing to deterioration, organic growths or deposits, and may exhibit cracks, holes, nodules, washouts and other imperfections.

4.3 Flow Conditions in the Closed Conduit

4.3.1 Hydraulics

Closed conduits are so designed and constructed to produce a self-cleaning velocity that prevents the deposition of solid matter in the invert. Thus, flow is predominantly turbulent and sub-critical.

4.3.2 Fluid Properties

Flow in closed conduits may range from clear water, free from contaminants, to liquids containing both suspended and floating solid matter and other dissolved or immiscible corrosive chemicals. The fluid itself may be an admixture of several substances each with its own characteristic properties.

5 OPERATIONAL CONDITIONS

5.1 General

Equipment to be used for the determination of flows or levels in closed conduits is normally located within the confines of the closed conduit system as shown in Fig. 1. In such cases it shares the same environmental operating conditions as the flow itself. In most cases flow measurement equipment comprises both sensing and display/recording elements. The display/recording element is often located outside the conduit system, where it is to be expected that the environmental conditions are different from those within the conduit system.

The manufacturers should ensure that the equipment is so designed and manufactured that it can operate satisfactorily under a range of conditions or can be readily adapted to operate under different circumstances, as specified by the user.

5.2 Environment within the Conduit System

5.2.1 The atmosphere within a conduit system may be assumed to be in equilibrium with the liquid in the conduit. If the atmosphere is of a toxic and/or corrosive nature, appropriate precautions should be taken to protect equipment from its effects.

It is possible, in certain circumstances, that the atmosphere may be of a potentially explosive nature. In this case, the equipment should be intrinsically safe for operation in such an atmosphere (for example, the electrical circuits should be so constructed that they cannot cause ignition of the atmosphere).

5.2.2 The extremes of the atmospheric environment within which the equipment is expected to operate should be specified by the user in terms of temperature, humidity and pressure. In addition, it should be noted that the atmosphere within the conduit system is likely to contain concentrations of gases such as H_2S , SO_2 , CO , inflammable gases, chlorine and ammonia. The presence of all or any of these gases should be specified by the user.

5.3 Flow Conditions within the Conduit System

5.3.1 Discharge in closed conduit systems may vary over a wide range from zero to many cubic metres per second.

5.3.2 The depth of flow will normally be limited by the height of the conduit. Under abnormal conditions of flow when the conduit is surcharged, the head of flow between the invert of the conduit and the level of the free surface may be equivalent to several conduit diameters. Equipment should not be damaged by the occurrence of such conditions. When ordering equipment, the user should specify the range of conditions under which the equipment is required to operate and to yield data in accordance with the uncertainty values given in 8. Such a specification should include details of:

- a) Depth of flow (that is, the operating range);
- b) Head of flow (head under which equipment will not be damaged or leak);
- c) Range of velocity;
- d) Whether supercritical flow is to be expected,
- e) Water quality (including the presence of contaminants and the water temperature);
- f) Nature, concentration, etc, of floating solids;
- g) Bed load/suspended load;
- h) Nature, concentration, of suspended solids, and
- j) Atmospheric temperature, pressure, humidity and quality.

5.4 Environment Outside the Conduit System

Where elements of the equipment are situated outside the conduit system, the user should specify the environmental conditions under which the elements are required to operate. Such a specification should include, for example, details of:

- a) Atmospheric temperature and relative humidity,
- b) Likelihood of electrical interference, and
- c) Likelihood of mechanical shock.

6 CHOICE OF MEASUREMENT REACH

In general, a measurement reach shall be chosen that is

clear of hydraulic discontinuities throughout the flow determination range. This means that the reach selected shall be free from bends, changes in cross-sectional shape or size, changes in gradient, junctions or bifurcations, access shafts or any other impediments to free smooth flow. It is recommended that the monitoring equipment is sited at least three or four conduit diameters upstream of such disturbances.

However, if dilution gauging is the selected method of measurement, irregularities in the conduit shape and flow disturbances will enhance mixing, allowing relatively short mixing lengths to be used.

NOTE — The transition between free surface flow and flow under surcharged conditions may be very turbulent with large variations in air entrapment.

7 FUNCTIONAL REQUIREMENTS

7.1 The equipment should be designed and manufactured, or able to be adapted, to operate in one or more of the following modes:

- a) *Permanent installation* — the equipment is required to measure flow or level over a long period of time (more than 12 months);
- b) *Temporary installation* — the equipment is required to measure flow or level for a specific period of time (not more than 12 months); and
- c) *Portable survey installation* — the equipment is required to determine the flow for a short period of time, without permanent site fixture of any element of the measuring equipment.

7.2 Equipment normally comprises three basic elements, that is

- a) Sensor,
- b) Transducer, and
- c) Indicator/Recorder.

All the elements may be installed within the conduit system or, alternatively, the sensor may be installed within the conduit system and the indicator/recorder installed outside, and possibly remote from the conduit system.

7.3 No element of the equipment should cause any significant interference with the flow itself and, in particular, should not present any edge or surface to which suspended or floating debris could attach itself. It is permissible under certain circumstances for sensors to be mounted within the wall of the conduit. If such an arrangement is required, it should be specified by the user at the time of order, and the manufacturer should provide the appropriate installation arrangements.

7.4 Once installed, the sensor should require a

minimum of physical checking or other form of physical attention.

In the case of a permanent installation, the sensor should not require removal for off-site maintenance at intervals of less than 5 years. However, if frequent maintenance is required, then provision should be made at the outset for easy removal of the equipment from the conduit.

In the case of a temporary installation, the sensor should operate without attention for the whole of the measuring period.

For a portable survey device, the sensor should be installed and removed at the time of each measurement.

7.5 The space available in most closed conduit systems is limited. The installation of equipment should be possible without interrupting the flow. In general, equipment should be installed so that it does not restrict movement within the access shaft. If, however, it is necessary to install the indicating/recording equipment in the access shaft, it should be able to be removed without interrupting the collection of data. Any other element of the equipment, including the flow sensor(s), should remain fixed in position until such time as removal becomes necessary for servicing, repair or renewal, or the abandonment of the site.

7.6 For ease of transportation, it is desirable that no single item of equipment should exceed a maximum dimension of 2 m. The dimensions of the sensor, and of the measuring or recording equipment (if it is installed in the conduit system), should not exceed 0.5 m, which is commensurate with the minimum size of access shaft. The equipment should be portable either as a unit or in parts.

7.7 Parts of the equipment, which are to be operated below the surface of the liquid being monitored, should be sealed to withstand pressures of at least five times the conduit diameter or its equivalent height subject to a minimum head of 10 m.

7.8 When the indicating/recording equipment is installed within the conduit system, the equipment should be sealed so that it can withstand immersion under a head of at least few times the conduit diameter or its equivalent height of liquid for a long period without affecting its operation.

7.9 The maximum distance between the sensor and the recorder should be commensurate with the specified site.

7.10 The recording equipment should be capable of storing all data collected between attendance intervals.

8 PERFORMANCE SPECIFICATION

8.1 Parameter Value

8.1.1 Equipment should be capable of measuring and, as appropriate, recording parameter values throughout the full range of operating conditions with an uncertainty level of ± 10 percent of the measured value of the parameter or ± 1 percent of the full-range value, whichever is the smaller.

NOTE — In this context, full-range means the full range of the open channel flow conditions.

8.1.2 The sensor should respond to changes in parameter values in less than 5 s.

8.1.3 Equipment should incorporate facilities for

damping short-period oscillations (of the order of 5 s) in the parameter value.

8.2 Timing Device

Where a timing device is used for controlling sampling of parameter values at discrete time intervals, the frequency of sampling should be able to be regulated by the user. The operation of the equipment should be matched to the particular requirement of the user and related to the specific conditions of flow in the closed conduit.

9 ADDITIONAL REQUIREMENTS

Any aspects of equipment specification not covered in this standard should be the subject of specific agreement between the user and the manufacturer.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act, 1986* to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

This Indian Standard has been developed from Doc : No. WRD 1 (357).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters :

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002
Telephones : 2323 01 31, 2323 33 75, 2323 94 02

Telegrams : Manaksanstha
(Common to all offices)

Regional Offices :

	Telephone
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110 002	{ 2323 76 17 2323 38 41
Eastern : 1/14 C.I.T. Scheme VII M, V. I. P. Road, Kankurgachi KOLKATA 700 054	{ 2337 84 99, 2337 85 61 2337 86 26, 2337 91 20
Northern : SCO 335-336, Sector 34-A, CHANDIGARH 160 022	{ 260 38 43 260 92 85
Southern : C.I.T. Campus, IV Cross Road, CHENNAI 600 113	{ 2254 12 16, 2254 14 42 2254 25 19, 2254 23 15
Western : Manakalaya, E9 MIDC, Marol, Andheri (East) MUMBAI 400 093	{ 2832 92 95, 2832 78 58 2832 78 91, 2832 78 92

Branches : AHMEDABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. FARIDABAD.
GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. NAGPUR.
NALAGARH. PATNA. PUNE. RAJKOT. THIRUVANANTHAPURAM. VISAKHAPATNAM.